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PATENT
1501-1170

IN THE U.S. PATENT AND TRADEMARK OFFICE BEFORE THE BOARD OF PATENT APPEALS AND INTERFERENCES

In re application of

Sergey K. GORDEEV et al.

Application No. 09/424,760

Filed February 3, 2000

METHOD FOR PRODUCING A POROUS CARBON ARTICLE AND AN ARTICLE PRODUCED THEREBY

Appeal No.

Conf. 8547

Group 1754

Examiner S. Hendrickson

APPEAL BRIEF

MAY IT PLEASE YOUR HONORS:

March 9, 2005

1. Real Party in Interest

The real party in interest in this appeal is the assignee, FOC FRANKENBURG OIL COMPANY EST of Vaduz, Liechtenstein.

2. Related Appeals and Interferences

Appellants are unaware of any prior or pending appeals, interferences or judicial proceedings which may be related to, directly affect or be directly affected by or have a bearing on the Board's decision in the pending appeal.

3. Status of Claims

Claims 24-40 are pending. The present appeal is taken from the final rejection of all the claims 24-40 in the outstanding Official Action dated June 14, 2004.

4. **Status of Amendments**

Pursuant to 37 CFR § 41.33(b), an amendment is filed with this Appeal Brief cancelling claims 18-23. Claims 18-23 were withdrawn from further consideration as allegedly being directed to a non-elected invention. No other amendments have been filed subsequent to final rejection.

5. **Summary of Claimed Subject Matter**

Normally, in the development of a new material, the material is first produced and then characterized and utilized based on its properties. However, this is a time and labor consuming method. It would be preferred if the functional and material properties of an article could be predicted in advance.

The claimed invention is directed to a method for producing a porous carbon article (present specification, pg. 1 , lines 5-10), wherein the size of the pores of the article can be predicted in a direct and efficient manner. Appellants have suprisingly discovered that the size of the pores of the article can be controlled by using a simple calculation (pg. 2, lines 18-28). The calculation is used to select the particular carbide material used in the production of the article and to predict the size of the pores (amended sheet pg. 3, lines 1-21; see preliminary amendment of November 30, 1999).

The porous carbon article is produced by forming an intermediate body with transport pores from shaping powders of at least one carbide of an element selected from the group

consisting of Groups III, IV, V and VI of Mendelyv's Periodic System, the at least one carbide having physical and chemical constants to obtain a porous carbon article having a desired nanoporosity by calculating (pg. 8, lines 1-10):

$$X = Z*(1-R)/R$$

wherein X = specified size of desired nanopores and $X \leq 10$ nm, nm;

$Z = 0.65\text{-}0.75$ nm;

$R = \nu M_c = \rho_k / M_k \rho_c$

where

M_c - molecular mass of carbon, g/mole;

M_k - molecular mass of the selected carbide, g/mole;

ρ_k - density of the selected carbide, g/ccm;

ρ_c - density of carbon, g/ccm;

ν - number of carbon atoms in carbide molecule,

heat treating the intermediate body thereby producing a work piece in the form of a rigid carbonaceous skeleton (amended sheet pg. 3, lines 20-30; see preliminary amendment of November 30, 1999), and thereafter thermochemically treating the work piece to produce the porous carbon article (amended sheet pg. 6, lines 1-10; see preliminary amendment of November 30, 1999).

Thus, the claimed invention is directed to a method for producing a porous carbon article that utilizes a simple calculation to predict the nanoporosity of the porous carbon article in a direct and efficient manner. By doing so, porous

carbon articles such as electrodes can be made with a desired porosity.

6. **Grounds of Rejection to be Reviewed on Appeal**

1. Claim 28 was rejected under 35 USC. §112, second paragraph, for allegedly being indefinite.

2. Claims 24-40 were rejected under 35 USC §112, first paragraph, for allegedly containing subject matter which was not described in the specification in such a way as to reasonably convey to one skilled in the relevant art that the inventor, at the time the application was filed had possession of the claimed invention.

7. **Argument**

ARGUMENTS CONCERNING FIRST GROUND OF REJECTION

Claim 28 is definite to one of ordinary skill in the art. The test of indefiniteness is whether one skilled in the art would understand the scope of the claim when read in light of the specification. *Bausch & Lomb, Inc. v. Alcon Labs. Inc.,* 64 F.supp. 2d 233, 52 USPQ 2d 1385 (DCW DNY 1999), citing *Amgen Inc. v. Chugal Pharm. Co. (*Fed. Cir.) *infra, Morton Int. Inc. v. Cardinal Chem. Co.,* 5 F.3d 1464, 28 USPQ 2d 1190 (Fed. Cir. 1993). In imposing the rejection, the Official Action alleges that the phrase "predetermined volume of transport pores" is indefinite.

However, the specification states at page 16, lines 24-35 (see amended sheet pg. 16; preliminary amendment of November 30, 1999) that the phrase "predetermined volume of transport pores" relates to the mathematical symbol of V_{tr}. V_{tr} is then further defined by mathematical formula in the present specification at page 19, lines 22-25.

Thus, in view of the present specification, appellants believe that the phrase is definite to one ordinary skill in the art.

ARGUMENTS CONCERNING SECOND GROUND OF REJECTION

In view of the present disclosure, appellants believe that Claims 24-40 satisfy the requirements of 35 USC §112, first paragraph. Whenever the issue arises as to whether the claimed invention satisfies the written description requirement, the factual inquiry is whether the disclosure conveys with reasonable clarity to those skilled in the art that, as of the filing date sought, applicant was in possession of claimed the invention. See, e.g., *Vas-Cath, Inc. v. Mahurkar*, 935 F.2d 1555, 1563-64, 19 USPQ2d 1111, 1117 (Fed. Cir. 1991). Upon reviewing the present disclosure, appellants believe that it is apparent that the present specification conveys with reasonable clarity to one skilled in the art that, at the time the application was filed, appellant was in possession of the subject matter of claims 28-40.

In rejecting the claims, the Office Action alleges that the written description requirement is not satisfied because A) the basis for selecting the density of carbon is not given; and B) the formula equation recited in claim 24 (the equation is also recited in claim 27) contradicts known scientific facts in that the equation found in claim 24 implies that there cannot be a continuum of porosities for carbide because the numbers used to derive the porosity are invariant. However, appellants believe that the Office Action is mistaken on both points.

A) <u>ONE OF ORDINARY SKILL IN THE ART WOULD UNDERSTAND THE BASIS FOR SELECTING THE DENSITY OF CARBON UPON REVIEWING THE PRESENT SPECIFICATION.</u>

As to the density of carbon, the claimed invention utilizes a chemical reaction of carbide compounds wherein the resulting elemental carbon typically approaches the density of 2.2 g/ccm.

Appellants have surprisingly discovered that a simple relation exists for certain carbide materials in that metal atoms can be removed from a crystal/particle without having the size and shape of its original geometrical form changed. In other words, a metal can be removed leaving the nanoporosity uniformly distributed throughout the remaining elemental carbon.

This is the basis as to why such simple and well known parameters such as the number of carbons in the metal carbide molecule unit and atomic weights of the elements involved can be

used to calculate the molecular mass of the metal carbide. The atomic/molecular mass of carbon is 12.

As to the density of carbon, appellants note that elemental carbon is known to crystallize in two major forms, i.e., diamond and graphite. The densities for each of these carbon forms are distinct and well documented in physical/chemical Tables. Indeed, it is well known that diamond is a crystal form of carbon that is thermodynamically stable only at extremely high pressures. As a result, in the claimed invention, one skilled in the art would understand that the elemental carbon that forms approaches the normal low-pressure form of graphite.

In technical literature the term "carbon" has been used at times to describe any pure carbon material. Such a "carbon" material might have a density that depends on its manufacture and resulting microstructure, pores or faults. However, in the claimed invention, appellants are using a chemical reaction of carbide and the resulting elemental carbon approaches the density of the normal low-pressure graphite form of 2.2 g/ccm. Indeed, this is shown in Example 1 beginning on page 14 of the present specification.

As a result, upon reviewing the present specification, appellants believe that one skilled in the art would understand the basis for selecting the density of carbon.

B) <u>THE CLAIMED METHOD IS DIRECTED TO A METHOD OF PRODUCING A POROUS CARBON ARTICLE BY SELECTING APPROPRIATE CARBIDE OR CARBIDES TO OBTAIN A DESIRED NANOPOROSITY AND DOES NOT CONTRADICT KNOWN FACTS OF SCIENCE.</u>

In arguing that the equation found in claim 24 implies that there cannot be a continuum of porosities for carbide because the numbers used to derive the porosity are invariant; applicants believe that this demonstrates that the Office Action misinterprets the claimed relationship between selecting the appropriate carbide material and obtaining a porous carbon material with the desired nanoporosity.

Contrary to the contentions of the Office Action, the equation in claim 24 (also recited in claim 27) does not suggest that all carbides have the same porosity or that the type of carbide material utilized in the claimed invention is invariant. Rather, the formula at issue allows one skilled in the art to select the appropriate carbide or carbides with the desired properties needed to obtain the desired porosity in the porous carbon article.

Moreover, it is neither recited in the claims nor possible to randomly pick an element off the periodic table and still obtain the desired nanoporosity. Upon selecting the desired size of the nanopores, one skilled in the art would work through the equation to obtain the appropriate carbide material. Thus, one skilled in the art can reduce the trial and error needed to

produce a porous carbon article with the desired porosity by selecting the appropriate carbide material as set forth in the claimed invention.

Indeed, the claimed invention is directed to a method for producing a porous carbon article. The claimed invention does not claim a mathematical formula per se. In this regard, the Office Action does not consider the additional steps recited in the claim, or how they relate the equation.

In addition, the claimed method does not recite that a porous carbon article can be produced with any wished-for porosity. Instead, claim 24 recited that "X = specified size of desired nanopores and $X \leq 10$ nm". Thus, producing a porous carbon article that possesses any wished-for porosity is not within the scope of the claims.

Appellants understand the concern of the Office Action as to what would happen if one skilled in the art desired a particular porosity but picked a carbide material that did not produce the desired porosity. However, in view of the present disclosure and claimed method, appellants believe that it would be within the purview of one skilled in the art to merely select another carbide or carbides as set forth in the claimed method to obtain a porous carbon article with the desired porosity.

While the Office Action cites to GOLDBERGER 4,543,240 in support of its position, GOLDBERGER relates to a technique for the production of metal carbides and is directed to the

manufacture of coarser SiC particles. Column 2 of GOLDBERGER indicates that fine precursor particles, less than approximately 10 microns in diameter, can be used to form SiC of "extremely small" particle size. In column 7, GOLDBERGER states that micro-cracks and micro-porosity can make particles having a substantially higher surface area.

Forming particles with defects that are micro-sized is not the same as porosity. Micron sized particles can still be SiC, despite the presence of micro-cracks or micro-pores. Substantial areas between the defects will be crystalline SiC and follow the relationships mentioned in the application by removing silicon and forming nanopores on a 3 to 4 magnitude lower level than these defects.

At this time, appellants note that the Office Action requested data showing the production of a porous carbon article in accordance with the claimed invention that exhibited a porosity of 2.6 nm. However, an application as filed is presumed to be adequate, unless or until sufficient evidence or reasoning to the contrary has been presented by the Patent Office to rebut the presumption. See, e.g., *In re Marzocchi*, 439 F.2d 220, 224, 169 USPQ 367, 370 (CCPA 1971). In other words, the Patent Office has the initial burden of presenting by a preponderance of evidence why a person skilled in the art would not recognize in an applicant's disclosure a description of the invention defined by the claims. *In re Wertheim*, 541 F.2d 257, 263, 191 USPQ 90, 97. As

outlined above, appellants believe that the Office Action fails to provide any reasoning or evidence as to why a person skilled in the art would not recognize in appellant's disclosure a description of the claimed invention.

As a result, appellants believe that the showing requested by the Office Action was not necessary. Nevertheless, in the interest of advancing prosecution, appellants submitted the results of several carbide materials that could be practiced with the claimed invention. While appellants do not provide a porous carbon article having a porosity of 2.6 nm, appellants believes that the Office Action fails to provide the necessary reasoning or evidence to justify such a request.

Finally, while the results submitted by the appellant suggest that chromium does not adhere to the relationship of the formula of claim 24, appellants note that the presence of inoperative embodiments within the scope of a claim does not necessarily render a claim non-enabled. Indeed, the mere fact that a single inoperable species can be hypothesized with effort does not bear on enablement unless the proportion of inoperable species becomes significant in relation to the scope of the claim. *Atlas Powder Co. v. E.I. du Pont de Nemours & Co.*, 750 F.2d 1569, 1577, 224 USPQ 409, 414 (Fed. Cir. 1984). While chromium may not adhere to the relationship of the formula of claim 24, appellants note that the Office Action fails to fails to provide any evidence that

the proportion of inoperable species becomes significant in relation to the scope of the claimed invention.

Indeed, a disclosure of a large number of operable embodiments and the identification of a single inoperative embodiment did not render a claim broader than the enabled scope because undue experimentation was not involved in determining those embodiments that were operable. *In re Angstadt*, 537 F.2d 498, 502-503, 190 USPQ 214, 218 (CCPA 1976). Upon reviewing the present disclosure, appellants note that a number of carbides that can be practiced with the claimed method are recited in the specification and the additional results submitted by applicant. Moreover, appellants note that a full explanation is provided as to why chromium functions differently from other know carbide powders.

Moreover, appellants note that the claimed invention is directed to a selection technique for making products in a more direct and efficient manner. Thus, this is not reflect the situation of a generic formula embracing possibly inoperative species, because in the claimed invention, the equation does not solely define what is claimed.

In light of the enabled embodiments identified in the present specification and later remarks, appellants believe that the identification of chromium as a single inoperative embodiment does not render claims 24-40 broader than the enabled scope.

Thus, as the present disclosure does provide the basis for selecting the density of carbon and plainly teaches that the claimed method is directed to a method for producing a porous carbon article with a desired nanoporosity in advance by selecting the appropriate carbide powders within the context of the claimed method, appellants believe that the present disclosure conveys with reasonable clarity to those skilled in the art that, as of the filing date sought, applicant was in possession of claimed the invention.

Conclusion

It is believed to be apparent from the above discussion that neither of the rejections on appeal should be maintained, but instead that both should be reversed. Thus, in view of the above, the reversal of these rejections is accordingly respectfully requested

Respectfully submitted,

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8. **Claims Appendix**

24. A method for producing a porous carbon article comprising the steps of:

selecting powders of at least one carbide of an element selected from the group consisting of Group III, IV, V and VI of Mendeleyv's Periodic System, the at least one carbide having physical and chemical constants to obtain a porous carbon article having a desired nanoporosity by calculating using the relationship:

$X = Z*(1-R)/R$

where X = specified size of desired nanopores and $X \leq 10$ nm;

Z = 0.65-0.75 nm;

$R = \nu M_c = \rho_k / M_k \rho_c$

where

M_c - molecular mass of carbon, g/mole;

M_k - molecular mass of the selected carbide, g/mole;

ρ_k - density of the selected carbide, g/ccm;

ρ_c - density of carbon, g/ccm;

ν - number of carbon atoms in carbide molecule;

forming an intermediate body with transport pores having a size larger than 100 nm by shaping the selected powders;

heat treating the intermediate body in a medium of gaseous hydrocarbon or hydrocarbon mixtures at a temperature exceeding the decomposition temperature for the hydrocarbon or

hydrocarbons until the mass of the intermediate body has increased at least 3% thereby producing a work piece in the form of a rigid carbonaceous skeleton; and

thereafter thermochemically treating the work piece in a medium of a gaseous halogen to produce the porous carbon article having nanopores of a size X.

25. The method according to claim 24, wherein the carbide powders are chosen in dependence of desired distribution of nanopores by sizes using the relationship:

$$\Psi_i = {}_{Ki}\varphi_i/\Sigma K_i\varphi_i$$

where Ψ_i - volumetric part of nanopores with size x_i in total volume of nanopores;

φ_i - volumetric part of i-th carbide in particle mixture;

n - number of carbides;

$$K_i = 1 - \nu M_c\rho_{ki}/M_{ki}\rho_c$$

where M_c - molecular mass of carbon, g/mole;

M_{ki} - molecular mass of i-th carbide, g/mole;

ρ_{ki} - density of i-th carbide, g/ccm;

ρ_c - density of carbon, g/ccm;

N - number of carbon atoms in carbide molecule.

26. The method according to claim 24, wherein the intermediate body has a porosity of 30-70 vol%.

27. A method for producing a porous carbon article comprising the steps of:

selecting powders of at least one carbide of an element selected from the group consisting of Group III, IV, V and VI of Mendeleyv's Periodic System, the at least one carbide having physical and chemical constants to obtain a porous carbon article having a desired nanoporosity by calculating using the relationship:

$X = Z*(1-R)/R$

where X = specified size of desired nanopores and $X \leq 10$ nm, nm;

$Z = 0.65-0.75$ nm;

$R = \nu M_c = \rho_k / M_k \rho_c$

where

M_c - molecular mass of carbon, g/mole;

M_k - molecular mass of the selected carbide, g/mole;

ρ_k - density of the selected carbide, g/ccm;

ρ_c - density of carbon, g/ccm;

ν - number of carbon atoms in carbide molecule;

forming an intermediate body with transport pores having a size larger than 100 nm by shaping the selected powders;

heat treating the intermediate body in a medium of gaseous hydrocarbon or hydrocarbon mixtures at a temperature exceeding the decomposition temperature for the hydrocarbon or hydrocarbons until the mass of the intermediate body has increased at least 3% thereby producing a workpiece in the form of a rigid carbonaceous skeleton; and

thereafter thermochemically treating the work piece in a medium of a gaseous halogen to produce the porous carbon article having nanopores of a size X, and

wherein the intermediate body has a porosity determined with the following relationship:

$\varepsilon_0 = (1 - \nu_{np}/\Sigma K_i\varphi_i) * 100$

ε_0 porosity of intermediate body vol%;

where

φ_i - volumetric part of i-th carbide in particle mixture;

ν_{np} - predetermined volumetric part of nanopores in final article;

$K_i = 1 - \nu M_c\rho_{ki}/M_{ki}\rho_c$

where

M_c - molecular mass of carbon, g/mole;

M_{ki} - molecular mass of i-th carbide, g/mole;

ρ_{ki} - density of i-th carbide, g/ccm;

ρ_c - density of carbon, g/ccm;

ν - number of carbon atoms in carbide molecule.

28. The method according to claim 24, wherein the treatment in a medium of gaseous hydrocarbon or hydrocarbon mixtures is carried out until the mass of the intermediate body has changed according to the following relationship:

$\Delta m = Q(\varepsilon_0 - V_{tr})/(1 - \varepsilon_0)$

where

Δm - relative change of intermediate body mass, g/g;

ε_0 - porosity of intermediate body, vol%;

V_{tr} - predetermined volumetric content of transport pores, vol%;

$$Q = \rho_c/\rho_{mix}$$

where

ρ_c = density of carbon, g/ccm;

ρ_{mix} = density of carbides mixture, g/ccm.

29. The method according to claim 24, wherein the intermediate body is formed by pressing.

30. The method according to claim 24, wherein the intermediate body is formed by slip casting, tape casting or slurry casting.

31. The method according to claim 24, wherein the mixture of hydrocarbons comprises a natural gas.

32. The method according to claim 31, wherein the treating in hydrocarbon medium is carried out at 750-950°C.

33. The method according to claim 24, wherein at least one of the hydrocarbons used during the treatment of the intermediate body in hydrocarbons medium is selected from the group consisting of acetylene, methane, ethane, propane, pentane, hexane, benzene and their derivatives.

34. The method according to claim 33, wherein the treating in hydrocarbon medium is carried out at 550-1200°C.

35. The method according to claim 24, wherein the particles of carbide or carbides of which the intermediate body is formed are arranged uniformly throughout its volume.

36. The method according to claim 24, wherein the particles of carbide or carbides of which the intermediate body is formed are arranged non-uniformly throughout its volume.

37. The method according to claim 24, wherein the gaseous halogen comprises chlorine.

38. The method according to claim 24, wherein the thermochemical treatment of the workpiece is carried out at 350-1200°C.

39. The method according to claim 38, wherein the thermochemical treatment is carried out at 500-1100°C.

40. The method according to claim 26, wherein the intermediate body has a porosity of 35-50 vol%.